An anatomical note on *Moellendorffia eastlakeana* (Möllendorff, 1882) a camaenid land snail from Vietnam (Gastropoda: Pulmonata: Camaenidae)

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ABSTRACT

Newly collected specimens of *Moellendorffia eastlakeana* (Möllendorff, 1882) expand the known range of this species into Vietnam. Using these new Vietnamese and existing museum samples we have re-described the species including new information on radula and genital anatomy. Comparison with the type material of *M. callitricha* (Bavay and Dautzenberg, 1899) from Vietnam suggested *M. callitricha* is a junior synonym of *M. eastlakeana*.

Additional keywords: Gastropoda, pulmonate, *Traumatophora*, *Chloritis*, *Trichelix*

INTRODUCTION

The land snail genus *Moellendorffia* Ancey, 1887, has a wide distribution in southeastern China, Hong Kong and Vietnam. The detached peristome, descending aperture with denticles, and hirsute shell with external furrows, confer a very distinctive morphology on the shells (Pilsbry, 1890, 1895, 1902, 1905; Yen, 1939; Azuma, 1982).

Currently, seven species are recognized within this genus, namely: *M. trisinuata* (von Martens, 1867), *M. eastlakeana* (Möllendorff, 1882), *M. hensaniensis* (Gredler, 1885), *M. loxotata* (Mabille, 1887), *M. messageri* (Bavay and Dautzenberg, 1899), *M. spurca* (Bavay and Dautzenberg, 1899), and *M. depressispira* (Bavay and Dautzenberg, 1908) (Pilsbry, 1905; Zilch, 1966; Richardson, 1985).

Originally, *Moellendorffia* was placed by Pilsbry (1890) in a section of *Helix (Stegodera)* Martens, 1876, then reclassified by Pilsbry (1894) as a subgenus of *Helicodonta* Férussac, 1819, and finally (Pilsbry, 1905) as a distinct southeastern Chinese and Indo-Chinese genus related to *Stegodera* and allied to *Chloritis* Beck, 1837. Likewise, *Trichelix* Ancey, 1887, was originally placed by Pilsbry (1905) along with *Moellendorffiella* Pilsbry, 1905, as subgenera within *Moellendorffia*, and *Traumatophora* Ancey, 1887, as a subgenus of *Stegodera*. Subsequently, Schileyko (2003) recognized *Trichelix* as a genus distinct from *Moellendorffia* and Zilch (1959) separated *Traumatophora* as a genus distinct from *Stegodera* on the basis of the possession of a dextral shell with apertural teeth.

The early descriptive work on *Mollendorffia* was restricted to shell morphology (e.g., Pfeiffer, 1862; Mabille, 1887; Bavay and Dautzenberg, 1899; 1908, Pilsbry, 1902; 1905). Subsequently, Habe (1957), Azuma (1982), and Schileyko (2003) provided some additional anatomical information for *M. trisinuata* and *Trichelix eucharista* (Pilsbry, 1902) (= *M. (Trichelix) eucharista*). In this article, we examine specimens of *M. eastlakeana* collected from a forest reserve in northern Vietnam and compare them to museum material originally collected from other locations.

MATERIALS AND METHODS

We examined three specimens of *M. eastlakeana* collected in May 1999 from the Huu Lien Nature Reserve, Lang Son Province, northeastern border of Vietnam, which are now deposited in the Chulalongkorn University, Museum of Zoology (CUMZ). Type and other materials were critically examined in the Senckenberg Museum, Frankfurt (SMF) and Muséum National d'Histoire Naturelle, Paris (MNHN). Terminology for soft anatomy follows that of Habe (1957) and Schileyko (2003). The terms "proximal" and "distal" refer to a position relative to the genital orifice. Methodology for whorl counts and shell measurements follow Kerney and Cameron (1979).

Abbreviations: **at,** atrium; **e,** epiphallus; **fl,** flagellum; **fo,** free oviduct; **gd,** gametolytic duct; **gs,** gametolytic

sac; **hw,** head wart; **ov,** oviduct; **p,** penis; **pp,** penial pilaster; **pr,** penial retractor muscle; **pv,** penial verge; **v,** vagina; **vd,** vas deferens; **vp,** vaginal pilaster.

SYSTEMATICS

Family Camaenidae

Genus *Moellendorffia* Ancey, 1887

Type species: *Helix trisinuata* von Martens, 1867, Hong-Kong, China; by subsequent designation of Pilsbry (1905: 64).

Diagnosis: Shell medium size (11.5×19.5 mm), depressed, rather thin, umbilicate and corneous to brownish. Spire low to slightly convex; embryonic shell nearly smooth; subsequent whorls granulated and with short to long periostracal hairs. Last whorl rounded to shoulder and suddenly descending anteriorly. Aperture trigonal or squarish, entirely free from preceding whorl; usually with barriers inside and externally marked with furrows. Peristome expanded and continuous. Penis and epiphallus long, flagellum short and vagina long. Penial wall with longitudinal pilasters. Radula with triangular-shaped teeth.

Moellendorffia eastlakeana (Möllendorff, 1882)

Helix eastlakeana Möllendorff, 1882: 185 (Tai-mo-shan, Kwangtung, China (= Hong Kong): Lectotype SMF 8328 by Yen, 1939); Möllendorff, 1885: 391, pl. 10, fig. 18. Ancey, 1887: 64

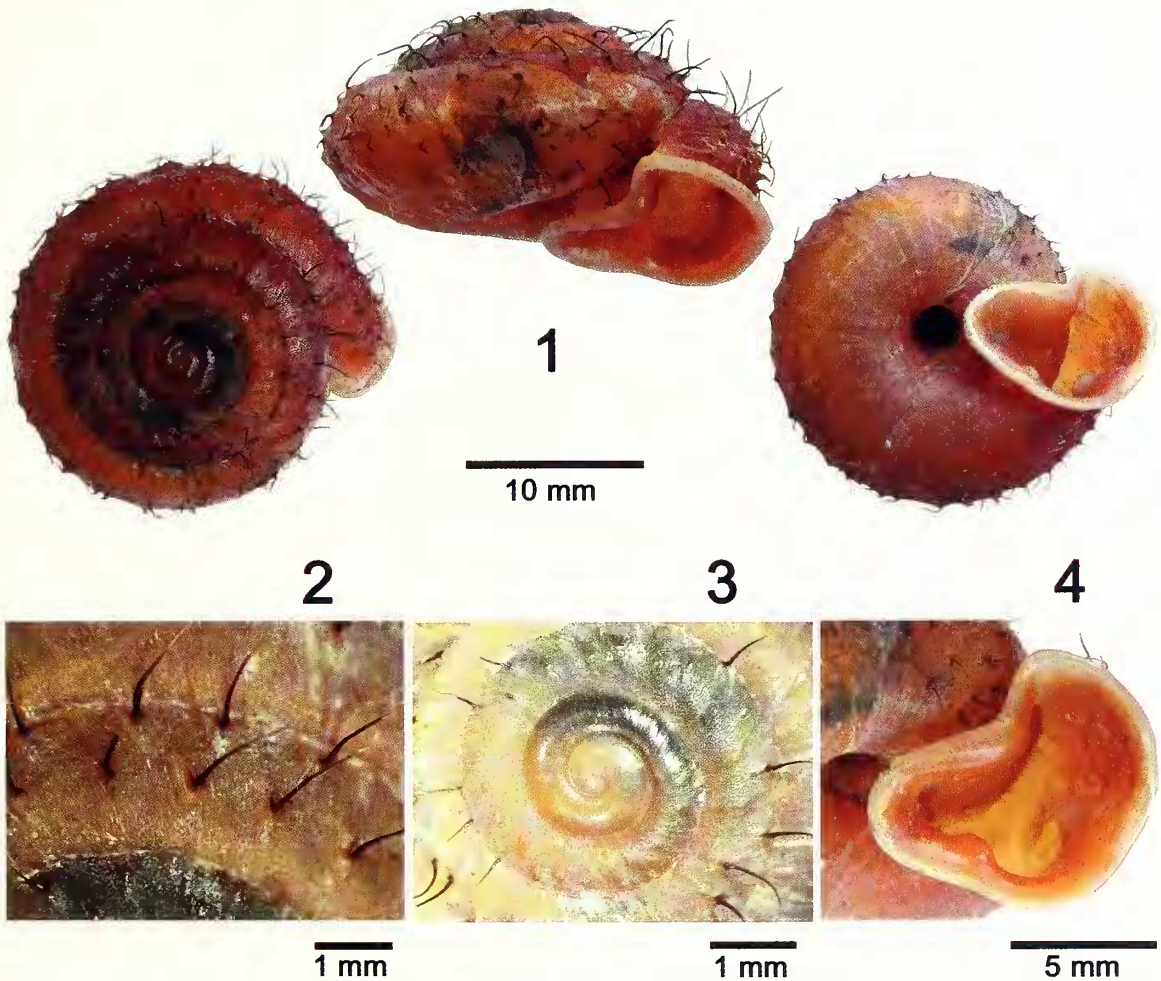
Helix (Moellendorffia) eastlakeana.—Pilsbry, 1890: 12, 13, pl. 1, figs 21, 22; Pilsbry, 1895: 290.

Stegodera eastlakeana.—Pilsbry, 1890: 310 (figure legend), pl. 1, figs 21, 22.

Helix (Moellendorffia) callitricha Bavay and Dautzenberg, 1899: 35, pl. 1, figs 6, 6[b] (That-Khé near Lang Son, Vietnam).

Moellendorffia eastlakeana.—Pilsbry, 1905: 65; Yen, 1939: 125, 228, pl. 13, fig. 3 (Lectotype SMF 8328); Richardson, 1985: 184.

Moellendorffia callitricha.—Pilsbry, 1905: 66; Richardson, 1985: 183.



Figures 1–4. Shell characteristics of *Moellendorffia eastlakeana*, CUMZ 2547. **1.** Shell morphology. **2.** Shell surface structure and showing the bristles on the periostracum. **3.** Protoconch sculpture **4.** Apertural lamellae.

Moellendorffia (Moellendorffia) eastlakeana.—Zilch, 1966: 210, pl. 6, fig. 52 (Lectotype SMF 8328).

Material Examined: Tai-mo-shan, Hong Kong: Lectotype SMF 8328, Paralectotype SMF 8329 (2 shells); Huu Lien Nature Reserve, Lang Son Province, Vietnam: CUMZ 2547 (1 specimen), CUMZ 2549 (2 shells); That-Khé, Tonkin, Vietnam (1 shell), MNHN Holotype of "*callitricha*"; That-Khé, Tonkin, Vietnam (2 shells), Denis collection (NMHN); That-Khé, Tonkin, Vietnam (1 shell), Staadt collection (NMHN); Tonkin, Vietnam (1 shell), Messager collection (NMHN); Tonkin, Vietnam (2 shells), Messager collection (NMHN)

Measurements: From 10 specimens analyzed; shell height ranged from 12.4 to 14.7 mm (mean 13.5±1.0 mm); shell width ranged from 20.8 to 23.9 mm (mean 22.0±1.2); and whorl count ranged from 6.0 to 6.1 whorls.

Shell: Shell (13.5 mm height, 22.0 mm width) slightly thin, translucent, depressed globose and deeply umbilicate. Spire flat to convex. Shell brownish to light brown; upper surface with long hairs (Figures 1, 2); lower surface with short hairs, few hairs around umbilicus. Shell surface rough, rows of tubercles running obliquely and descending, relatively smooth around umbilicus. Embryonic shell large and with very fine growth lines (Figure 3). Whorls 5-6, slightly convex and increasing regularly; suture depressed. Last whorl rounded and little convex below periphery. Aperture ear-shaped; lip margin light brown and continuously expanded; externally with furrows. Peristome free from preceding whorl and abruptly descending. Aperture brownish inside with well-developed, whitish, and semi-circular palatal and basal lamellae located closed to apertural lip. Two external furrows align with the internal apertural denticles. Parietal callus thickened, elevated, emarginated and obtusely projecting inward (Figure 4).

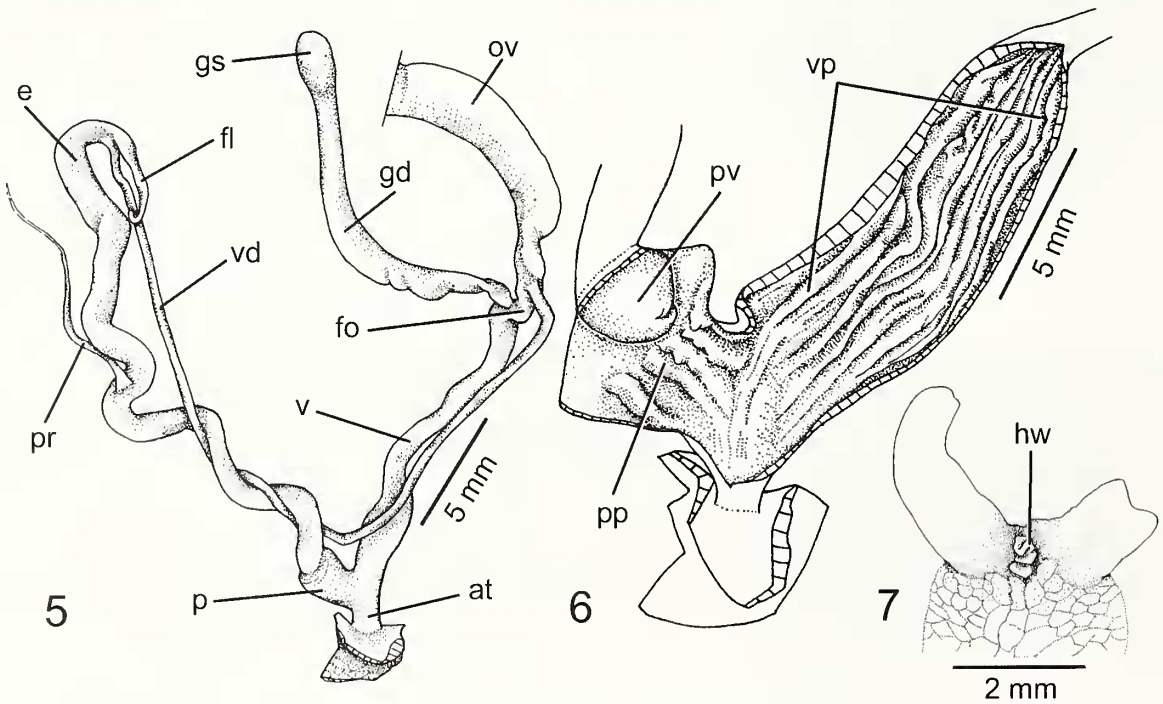
Genitalia: Atrium (**at**) short; penis (**p**) long; proximally with short penial verge and folded at penial verge based; distally long and somewhat slender. Epiphallus (**e**) shorter than penis. Flagellum (**fl**) short, small and without appendix. From free oviduct, vas deferens (**vd**) follows vagina and penis and connects distally on epiphallus. Penial retractor muscle (**pr**) thin and very long (Figure 5).

Internal wall of penis ribbed by series of swollen longitudinal pilasters (**pp**) (Figure 6). Smooth pilasters line introverted penial chamber and encircle penial verge tip. Penial verge (**pv**) short, conic and smooth (Figure 6).

Vagina (**v**) of similar length to penis, cylindrical and held in position by connective tissue attached to foot floor. Slightly swollen proximally; more slender distally. Gametolytic duct (**gd**) as wide as gametolytic sac (**gs**) for most of its length but narrows before gemetolytic sac. Free oviduct (**fo**) short; oviduct (**ov**) small (Figure 5).

Internal wall of vagina possess several longitudinal vaginal pilasters (**vp**) with smooth pilaster surfaces (Figure 6).

Animal: Live animal covered with blackish reticulated skin and dorsally with whitish stripe in middle of the



Figures 5–7. Reproductive system of *Moellendorffia eastlakeana*, CUMZ 2547. **5.** General view of the genital system. **6.** Interior structure of the atrium, penis and vaginal chamber. **7.** Dorsal view showing head wart.

body. A small curve-shaped head wart (**hw**) is loeated between the posterior tentacles (Figure 7). Foot narrow and long; mantle edge grayish; tentacles gray, and lower tentaeles paler. Mantle eavity with blackish pigmentation. Live snails possess short to long periostraeal hairs, whieh mostly break off after death.

Radula: Teeth arranged in anteriorly pointed V-shaped rows, eaeh row contains about 70 (34-(15-17)-1-(15-17)-35) teeth. Central tooth triangular with minute ectocones. Teeth beeome taller laterally. Lateral teeth tricuspid; endoeones and ectoeones small and located half way along tooth length (Figure 8). From tooth 16 to 17 outward lateral teeth, the marginal ectocone originates from the tooth base (Figure 9). Marginal teeth rather small, trieuspid and aligned obliquely; endocone becomes taller than mesocone; ectocone located basally (Figure 10), sometimes divided into two or three eusps in outermost teeth.

Distribution: *Moellendorffia eastlakeana* was previously known only from the type loeality: Tai-mo-shan, Hong Kong (Möllendorff, 1882, 1885; Pilsbry, 1890; Yen, 1939; Zileh, 1966). Our material was eollected from Huu Lien Nature Reserve, Lang Son Province, northeastern border of Vietnam.

Remarks: On examination of the holotype of *M. callitricha* and other topotypic material identified as this speeies, the only deteetable differenee was a slightly elevated spire relative to that of the lectotype of *M. eastlakeana* and other material recognized as *M. eastlakeana*. On this basis we consider *M. callitricha* to be a junior synonym of *M. eastlakeana*.

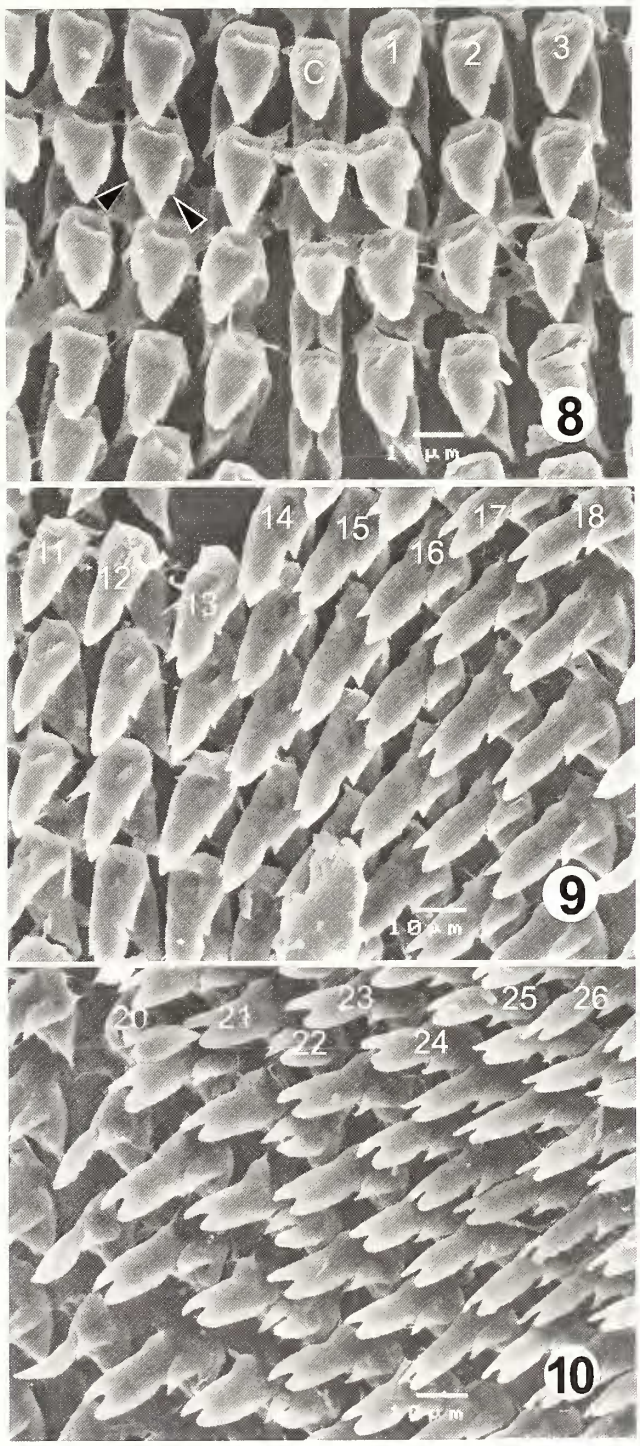
The locality characteristic of our sampling is monsoonal karst landform with high humidity. The snails oceurred among the tropical moist deeiduous forest. There was rain before the time of our visit in May, 1999. The snails were aetive, erawling on moist rotten logs.

Moellendorffia (M.) eastlakeana is distinctly different in shell morphology from *M. (M.) messageri* (Bavay and Dautzenberg, 1899), which occurs in the same area. The latter species has a much smaller shell (about 8 mm height; 14 mm width), flattened spire and shouldered last whorl.

DISCUSSION

The newly eolleeted material from Vietnam presents valuable additional information for the taxonomie revision of *Moellendorffia* and it allies. The presence of shell apertural lamellae and shell external furrows appear as eommon shell characters among *Moellendorffia*, *Trichelix*, and *Moellendorffiella*.

In eonsideration to the generie relationship, the presence of lamellae and external furrows could be common eharaeters among *Moellendorffia*, *Trichelix*, and *Moellendorffiella*. The long epiphallus, short flagellum, and triangular shape of the radula eentral tooth in both



Figures 8–10. Scanning electron micrographs of *Moellendorffia eastlakeana* radula, CUMZ 2547. **8.** Central teeth with the first to the third lateral teeth (black arrows indicate endocone and ectocone). **9.** Lateral teeth with the tricuspid marginal teeth transition. **10.** Marginal teeth. Central tooth is indicated by "C" and the other numbers indicate the order of lateral and marginal teeth.

Trichelix and *Moellendorffia* (Habe, 1957; Schileyko, 2003) may support their having a close relationship. The parietal callus free from a preceding whorl, with aperture lamellae, ear shaped aperture, and long hairs are possibly the distinctive characters of *Moellendorffia* sensu stricto. The position of two furrows (upper and lower periphery), parietal callus thickened at the edge, and tuberculated penial wall are probably the unique characteristics of *Trichelix*. Unfortunately, the anatomy of species of *Moellendorffiella* is still lacking for comparison, but the differences between shells of *Moellendorffiella* and *Moellendorffia* are the shouldered last whorl, flattened spire, parietal callus shortly attached to penultimate whorl, and rounded aperture (Pilsbry, 1890, 1905). These differences support the distinct generic position of *Moellendorffia*, *Trichelix*, and *Moellendorffiella* as proposed by Schileyko (2003). However, with so few samples and, especially, so few different species and informative morphological characters, the exact phylogenetic relationships remain equivocal. To better resolve the exact phylogeny, we suggest that the anatomical examination from more localities within each species range and from different species required is still insufficient, however a molecular based phylogenic approach is required in conjunction with morphology traits.

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